Performance Comparison of Straight and Curved Diffusers

AE 451A - Experiments in Aerospace Engineering-III

Propulsion Laboratory

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OBJECTIVE

To determine pressure recovery coefficient of a two-dimensional straight and a curved diffusers.

APPARATUS: Wind tunnel, Two-dimensional straight and curved diffusers, Pitot-static tube, Pressure sensors.

The open-circuit, low speed wind tunnel in the laboratory consists of a large fan, driven by an electric motor which sucks in air from the atmosphere through the side ports. Ashort diffuser section is attached to the fan housing to smoothen the flow before it enters the settling chamber fixed with honey-comb screens to dampen any circulatorymotion. The air stream is further accelerated in a small converging duct section and then becomes available for the experiment.

Physical dimensions and locations of various measurement taps for both straight and curved diffusers are shown in Figures 1 and 2.

PROCEDURE:

i. Familiarize with the general lay-out and major components of the wind tunnel.
ii. Sketch the general layout as well as identify the measurement locations for the straight and the curved diffusers.
iii. Install the straight diffuser at the wind tunne1 exit and connect the taps with the pressure sensors for observations. Switch on the tunnel and note measurements under steady condition. After completion of observations, repeat the experiment with the curved diffuser for the same fan speed.

MEASUREMENTS AND CALCULATIONS:

(A) Straight Diffuser:

i. Measure the length, the inlet and outlet dimensions ofthe straight diffuser. Calculate the area ratio, angle of divergence and length to inlet width ratio.
ii. Measure the wall pressure distribution using the pressure taps provided at various stations. For this purpose, use the static pressure at inlet to the diffuser as reference pressure.
iii. Measure the inlet dynamic head using a pitot-tube.
iv. Verify that, at aparticular station, the static pressure is uniform.
v. Obtain the velocity at the centre for different stationsusing pitot-static tube.

(B) Curved Diffuser:

i. Measure the curvature angle, the inlet and outlet dimensions of the curved diffuser. Calculate the area ratio.
ii. Measure the wall pressure distribution using the pressure taps provided at various stations. For this purpose, use the static pressure at inlet to the diffuser as reference pressure.
iii. Measure the inlet dynamic head using a pitot-tube.
iv. Obtain the velocity at the centre of various diffuser cross-sections using pitot-statictube.

The pressure recovery coefficient is, in general, defined as follows:

$$C_P = \left(\frac{1}{A_2}\int_{A_2} p dA - \frac{1}{A_1}\int_{A_1} p dA\right) \Big/ \left(\frac{1}{A_1}\int_{A_1} \frac{1}{2}\rho V^2 dA\right)$$

For the flow velocity, note that:

$$u = \sqrt{2(p_0 - p_\infty)/\rho_{air}}$$

In this experiment, the pressure measured at the inlet (p_∞) and at a particular downstream station in the diffuser (p) may be used to obtain the pressure recovery coefficient as follows:

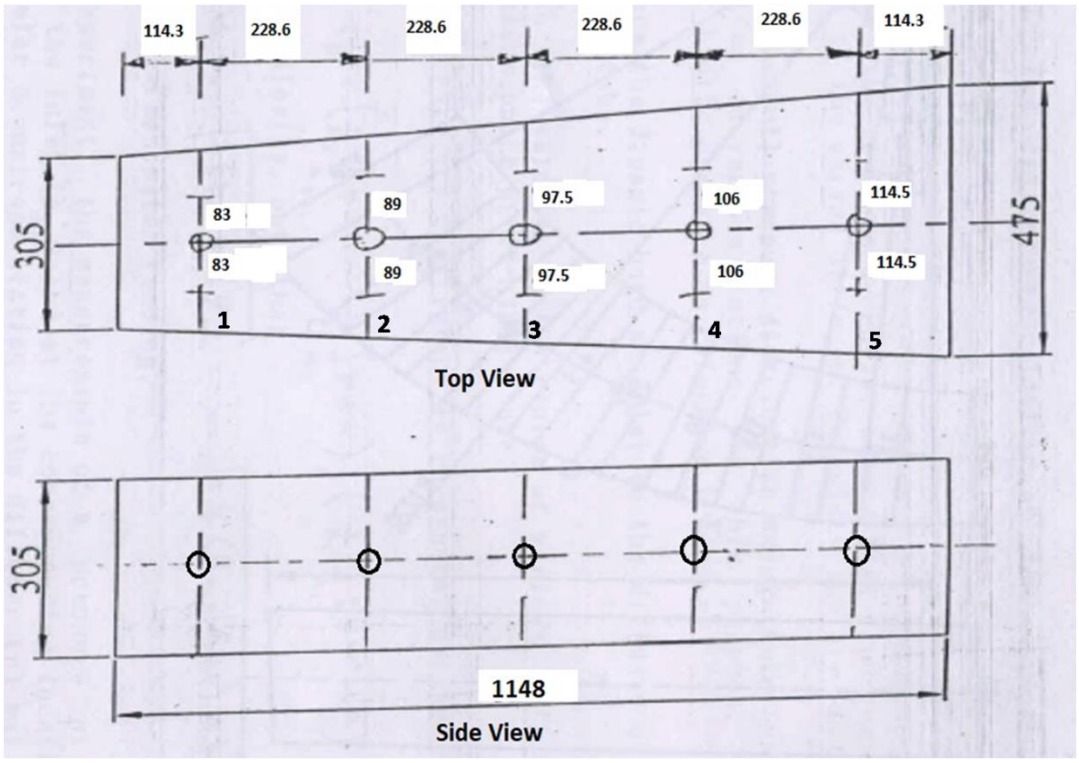
$$C_p = (p - p_\infty) \Big/ \frac{1}{2}\rho_\infty u_\infty^2$$

RESULTS AND DISCUSSION:

i. Plot the pressure-coefficient for various stations along the diffuser for both the diffusers.

ii. Compare the pressure recovery of straight and curved diffuser.

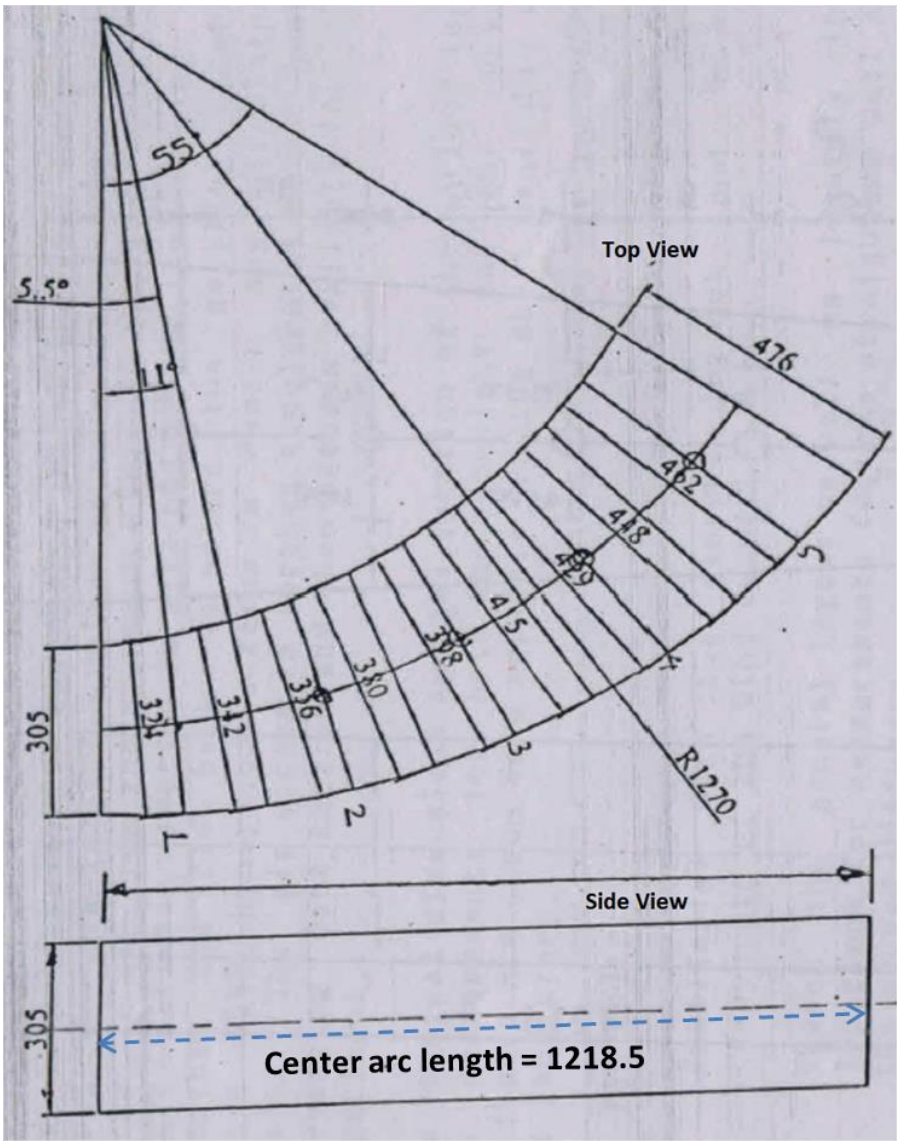
Discuss the salient features of data and curves obtained.



(a) Schematic

(b) Front and rear view with pressure taps

Figure 1 Straight Diffuser (All Dimensions are in mm)



(a) Schematic

(b) Front and rear view with pressure taps

Figure 2 Curved Diffuser (All the dimensions are in mm)

Figure 3 Experimental Facility (Wind Tunnel)